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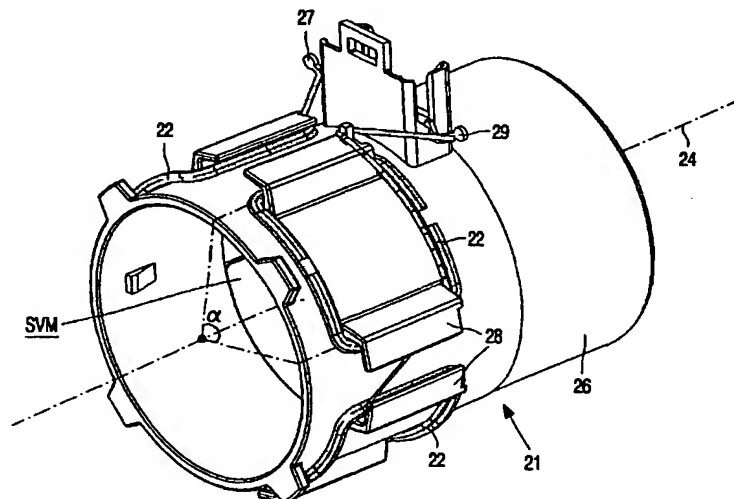
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: COLOR DISPLAY DEVICE HAVING QUADRUPOLE CONVERGENCE COILS



(57) Abstract: The invention relates to a color display device comprising an in-line electron gun (5) for generating three electron beams (6,7,8), and a convergence unit (14) to dynamically influence the convergence of the electron beams, preferably to decrease a distance (p) between the electron beams. The convergence unit (14) comprises a ring-shaped element (21) having four coils (22) and a longitudinal axis (24). A cross-section of the ring-shaped element (21) with a plane perpendicular to the longitudinal axis (24) is a circle with the longitudinal axis as its center and the ring-shaped element (21) forming the circumference. Each coil extends over the circumference over an angle  $\phi$  having a value between 50° and 75°.

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Color display device having quadrupole convergence coils.

The invention relates to a color display device comprising an in-line electron gun for generating three electron beams, and a unit for deflecting the electron beams across the color selection electrode.

5               Such display devices are known.

A present aim is to make the outer surface of the display window flatter, so that the image represented by the color display device is perceived by the viewer as flat. However, an increase of the radius of curvature of the outer surface will lead to an increase of a number of problems. The radius of curvature of the inner surface of the display window and of the  
10   color selection electrode should increase, and, as the color selection electrode becomes flatter, the strength of the color selection electrode decreases and hence the sensitivity to doming and vibrations increases. An alternative solution to this problem would be to curve the inner surface of the display window more strongly than the outer surface. By virtue thereof, a color selection electrode having a relatively small radius of curvature can be used. As a result,  
15   doming and vibration problems are reduced, however other problems occur instead. The thickness of the display window is much smaller in the center than at the edges. As a result, the weight of the display window increases and the intensity of the image decreases substantially towards the edges.

EP 0,421,523 discloses a color cathode ray tube with an in-line gun, a pin  
20   cushion correcting yoke and an eyebrow effect electronoptical distortion correction device comprising two pairs of coils, each pair having a coil on each outer electron beam side of the neck in the plane of the beams. The coil pairs are spaced apart along the z-axis between the gun and the yoke and are driven by a sawtooth current having a bow-tie envelope synchronous with the raster scan to correct the dynamic, antisymmetrical eyebrow effect apparent as a  
25   purity defect on the raster.

The non-prepublished applications PCT/IB98/02035 and US 09/218550 (attorneys' docket PHN 16.716) describe a color display device comprising a color cathode ray tube including an in-line electron gun for generating three electron beams being located substantially within a plane extending in an X-direction of a rectangular X-Y coordinate

system, a color selection electrode, deflecting means for deflecting the electron beams located at a deflection plane, and first and second influencing means to dynamically influence the convergence of the electron beams, to decrease a distance between the electron beams at a location of the deflection plane.

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It is an object of the invention to provide an improved color display device. To this end, the invention provides a color display device as defined in the independent claims and a method of manufacturing a convergence unit. The dependent claims describe advantageous embodiments.

10

These and other objects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is a sectional view of a display device, in which the invention is  
15 schematically shown;

Fig. 2 shows a schematic cross-section of the first convergence unit according to the invention; and

Figs. 3A,3B show an embodiment of the first convergence unit according to the invention.

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The figures are not drawn to scale. In the figures, like reference numerals generally refer to like parts.

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The display device shown in Fig. 1 comprises a cathode ray tube, in this example a color display tube, having an evacuated envelope 1 which includes a display window 2, a cone portion 3 and a neck 4. In the neck 4 there is arranged an in-line electron gun 5 for generating three electron beams 6, 7 and 8 which extend in one plane, the in-line plane, which is in this case the plane of the drawing. In the undeflected state, the central  
30 electron beam 7 substantially coincides with the tube axis 9.

The inner surface of the display window is provided with a display screen 10. The display screen 10 comprises a large number of phosphor elements luminescing in red, green and blue. On their way to the display screen, the electron beams are deflected across the display screen by way of an electromagnetic deflection unit 51 and pass through a color

selection electrode 11 which is arranged in front of the display window 2 and which comprises a thin plate having apertures 12. The three electron beams 6, 7 and 8 pass through the apertures 12 of the color selection electrode at a small angle relative to each other and hence each electron beam impinges only on phosphor elements of one color. The deflection unit 51 comprises, in addition to a coil holder 13, deflection coils 13' for deflecting the electron beams in two mutually perpendicular directions. The display device further includes means for generating voltages, which during operation are fed to components of the electron gun via feedthroughs. The deflection plane 20 is schematically indicated as well as the distance  $p$  between the electron beams 6 and 8 in this plane.

10           The color display device comprises two electron beam convergence influencing units 14, 14', whereby a first unit 14 is used, in operation, to dynamically bend, i.e. as a function of the deflection in a direction, the outermost electron beams towards each other, and a second unit 14' serves to dynamically bend the outermost electron beams in opposite directions.

15           The two units 14, 14' are positioned at some distance from each other, and are used to vary the distance  $p$ , as a function of the deflection, in a such a manner that the distance  $p$  decreases as a function of the deflection in at least one direction. The first unit 14 is positioned close to the gun and will be referred to as the "gun quadrupole", whereas the second unit 14' is located near the deflection unit and will be referred to as the "yoke quadrupole".

20

Fig. 2 shows a schematic cross-section of the first convergence unit 14 "gun quadrupole" according to an embodiment of the invention. The first convergence unit 14 comprises a ring-shaped element 21 having four coils 22 and a longitudinal axis 24. A cross-section of the ring-shaped element 21 with a plane perpendicular to the longitudinal axis results in a circle with the longitudinal axis 24 as its center and the ring-shaped element 21 forming the circumference. The in-line electron gun 5 for generating three electron beams 6, 7 and 8 is located substantially within a plane extending in an X-direction of a rectangular X-Y coordinate system. Each coil 22 extends over an angle  $\alpha$  over the circumference, the angle  $\alpha$  having a value between  $50^\circ$  and  $75^\circ$ . This embodiment of the convergence units has the advantage that magnetic quadrupole fields are generated, while undesired other order magnetic multiple fields are eliminated as good as possible.

25

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Figs. 3A, 3B show an embodiment of the first convergence unit 14 ("gun quadrupole"), which comprises a cylindrically shaped element 21 having an outer surface 26 that is provided with protrusions 28 around which four coils 22 are wound in respective stacks of wire. Pins 27 and 29 are a starting position, respectively an end position of the coil winding process and are also used as connection pins to the outside electronics. The thus obtained gun quadrupole 14 comprises four identical coils 22, where each coil 22 is located in a quadrant of the circle and symmetrically arranged with respect to a line that has an angle of  $45^\circ$  with the X-direction. This embodiment has the advantage that a quadrupole element is created that - during operation- is almost free of dipole, 6-pole or 8-pole magnetic field components.

Further, the angle  $\alpha$  has been chosen such that each coil 22 extends over an angle  $\alpha$  having a value of  $60^\circ \pm 5^\circ$ . Here the angle  $\alpha$  is measured from the middle of the stack of wires. This measure ensures the absence of 12-pole field components.

The cylindrical shape of the element 21 facilitates an easy positioning of the quadrupole in the neighborhood of the electron gun. A further advantage is that the cylinder may be used to contain additional coil elements SVM such as, for example a so-called Scan Velocity Modulator coil. This additional coil may be contained in the cylinder in the form of a wound-up foil.

In Fig. 3B the winding process is schematically indicated. Electrically conductive wire 25 is wrapped around pin 27 and -in this particular embodiment- 63 full turns in the clockwise direction around a first set of protrusions 28 are made. Next, the second coil 22 is made by 63 full turns in the anti-clockwise direction, etc. After having completed all four coils 22 in this way the wire is wrapped around pin 29.

In summary, a preferred embodiment of the invention relates to a color display device comprising an in-line electron gun 5 for generating three electron beams 6,7,8, and convergence unit 14 to dynamically influence the convergence of the electron beams, to decrease a distance  $p$  between the electron beams. The convergence unit 14 comprises a ring-shaped element 21 having four coils 22 and a longitudinal axis 24. A cross-section of the ring-shaped element 21 with a plane perpendicular to the longitudinal axis 24 is a circle with the longitudinal axis as its center and the ring-shaped element 21 forming the circumference. Each coil extends over the circumference over an angle  $\alpha$  having a value between  $50^\circ$  and  $75^\circ$ .

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative

embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of other elements or steps than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

## CLAIMS:

1. A color display device comprising  
an in-line electron gun (5) for generating three electron beams (6,7,8) being  
located substantially within a plane extending in an X-direction of a rectangular X-Y  
coordinate system,  
5                   deflecting means (51) for deflecting the electron, and  
                  convergence means (14) for dynamically influencing a convergence of the  
electron beams, the convergence means (14) comprising a ring-shaped element (21) having  
four coils (22) and a longitudinal axis (24), a cross-section of the ring-shaped element (21)  
with a plane perpendicular to the longitudinal axis (24) being a circle with the longitudinal  
10                   axis (24) as its center and the ring-shaped element (21) forming a circumference of the circle,  
each coil (22) extending over an angle  $\alpha$  over the circumference, the angle  $\alpha$  having a value  
between  $50^\circ$  and  $75^\circ$ .
2. A color display device according to claim 1, wherein  
15                   the deflecting means (51) deflect the electron beams at a deflection plane (20),  
and  
                  the convergence means (14) dynamically influence the convergence of the  
electron beams, to decrease a distance (p) between the electron beams at the location of the  
deflection plane (20).  
20
3. A color display device according to claim 1, wherein  
each coil (22) of the convergence means (14) extends over an angle  $\alpha$  having a value of  
 $60^\circ \pm 5^\circ$ .
- 25 4. A color display device according to claim 1, wherein  
each coil (22) of the convergence means (14) is located in a quadrant of the circle and  
symmetrically arranged with respect to a line that has an angle of  $45^\circ$  with the X-direction.
5. A color display device according to claim 1, wherein

the convergence means (14) comprise a cylindrically shaped element (21) having an outer surface (26) that is provided with protrusions (28) around which the coils (22) have been wound.

- 5 6. A method of manufacturing a convergence unit (14) for dynamically influencing a convergence of electron beams in a color display device, the method comprising the steps of :

providing a ring-shaped element (21) having a longitudinal axis (24), a cross-section of the ring-shaped element (21) with a plane perpendicular to the longitudinal axis (24)  
10 being a circle with the longitudinal axis (24) as its center and the ring-shaped element (21) forming a circumference of the circle, and

applying four coils (22) at the circumference of the ring-shaped element (21), each coil (22) extending over an angle  $\alpha$  over the circumference, the angle  $\alpha$  having a value between  $50^\circ$  and  $75^\circ$ .



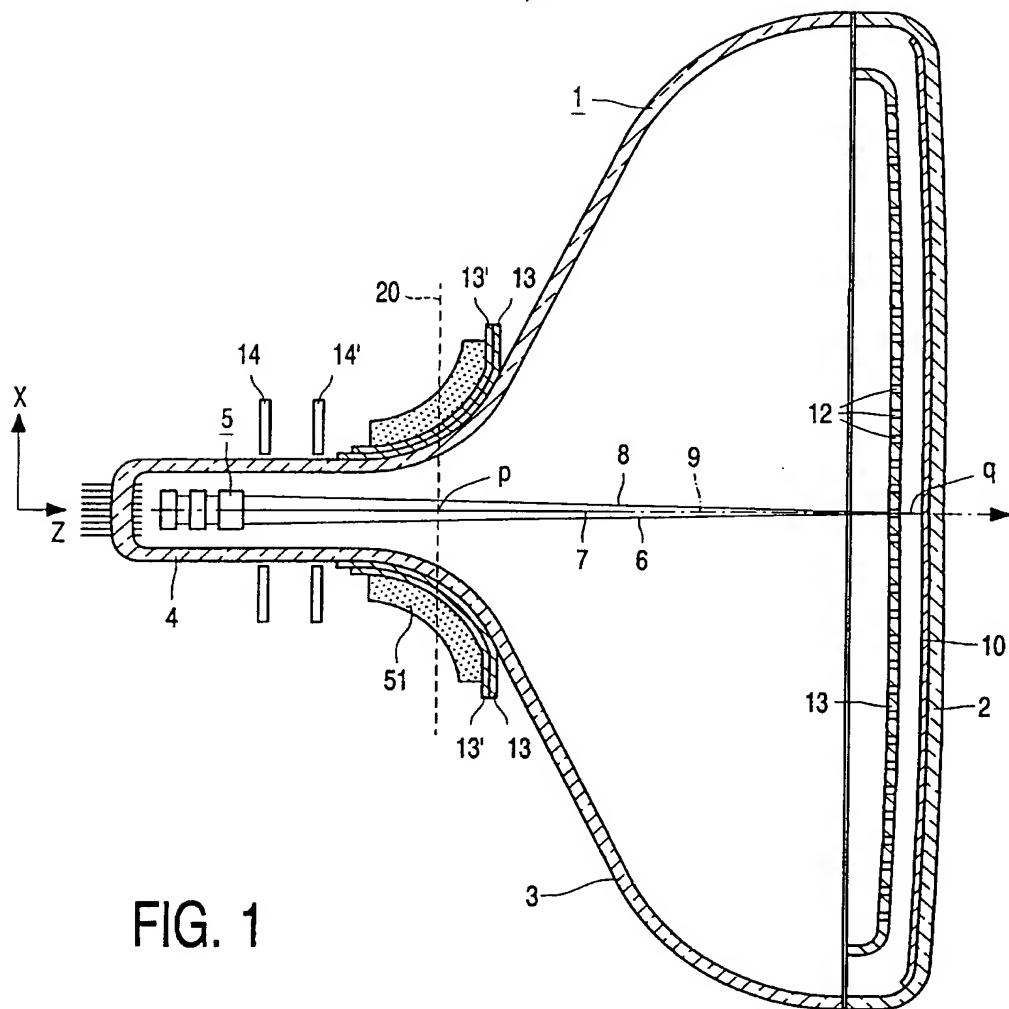
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FIG. 1

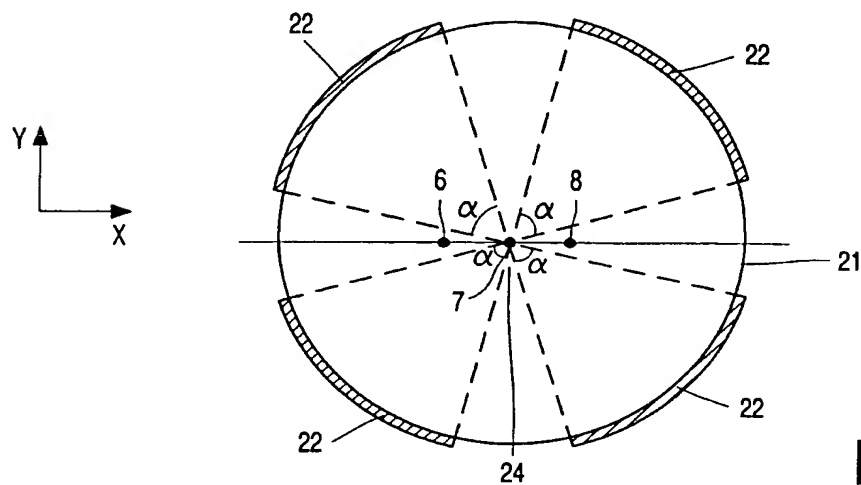


FIG. 2

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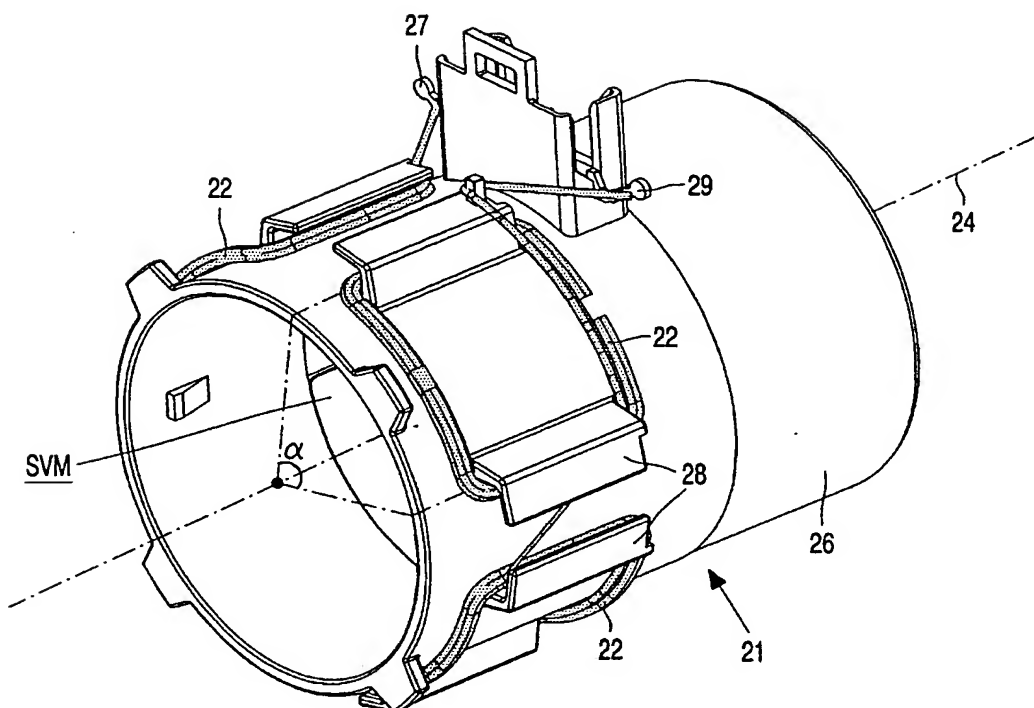
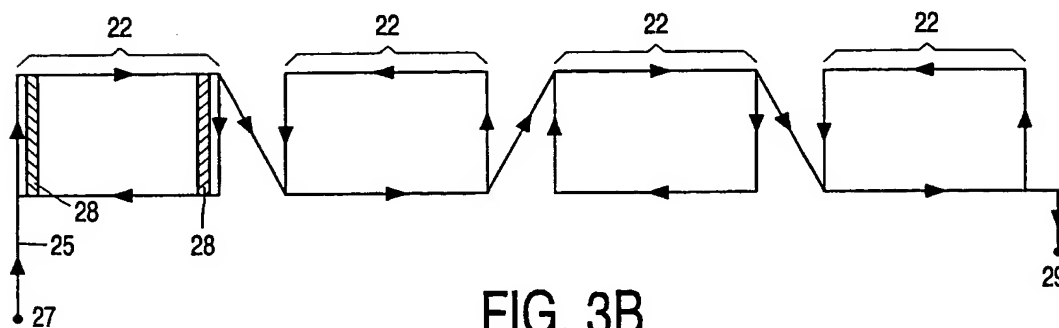


FIG. 3A



# INTERNATIONAL SEARCH REPORT

national Application No  
PCT/EP 00/05505

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 H01J29/70

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01J H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, WPI Data, EPO-Internal, COMPENDEX, INSPEC, IBM-TDB

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 565 732 A (SLUYTERMAN ALBERTUS A S ET AL) 15 October 1996 (1996-10-15) claim 1	1
A	US 4 117 434 A (LOGAN JAMES H) 26 September 1978 (1978-09-26) column 5, line 42-46; claim 1	1
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

5 October 2000

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# INTERNATIONAL SEARCH REPORT

national Application No  
PCT/EP 00/05505

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national Application No

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